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HUMAN CAPITAL AND LABOR TURNOVER IN MANUFACTURING INDUSTRIES: THE CASE OF AN ECONOMICALLY DEPRESSED REGION IN SOUTHEAST OHIO

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ABSTRACT

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THE CASE OF AN ECONOMICALLY DEPRESSED REGION IN SOUTHEAST OHIO

The study examines labor productivity and quit and layoff behavior of manufacturing production workers. Manufacturing firms employ relatively unskilled workers and make relatively small investments in specific human capital. To generate increasing income levels over time, industrial development efforts need to focus more on employment opportunities which require increasing skills.

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The major purposes of this study are to: (1) determine if human capital investment significantly influences the productivity of labor and other inputs used in manufacturing production processes, and (2) test the proposition that the lay-off rate is negatively related to a firm's investment in specific human capital, while the quit rate is negatively related to worker's investment in specific human capital,[1] in a five county region in Southeast Ohio: Athens, Gallia, Jackson, Meigs, and Vinton. This region is the area selected in Ohio for study under Title V of the Rural Development Act of 1972. Available data indicates that the manufacturing sector has been and continues to be one of the major sources of employment and income in the region. The study attempts to address questions like: What kinds of labor skills are in short supply in the region?; What are the alternatives for providing or developing the labor skills needed by manufacturing?; Is labor turnover a meaningful adjustment mechanism or a problem in the region?

The primary set of data is cross sectional micro-level data for calendar year 1974 or a fiscal year with greatest overlap of 1974. It is used to analyze the production processes and labor turnover rates of the manufacturing sector in the five counties. The data were obtained through mail questionnaire. Questionnaires were mailed to each of the 127 manufacturing firms in the region. Out of 53 questionnaires which were returned, 39 which is 30.7 percent were fully completed for the production analysis, while 49 which is 39 percent were useable for the labor turnover analysis.

Conceptual Models

The literature abounds with discussions of the influence of education, measured by years of schooling, on income distribution. The distribution of personal income is related to investment in human capital. The pure contribution of education to income levels has been questioned because the possible contribution of other factors such as "ability" and quality of schooling are all lumped under "contribution of education" (Layard and Psacharopoulos). However, even if downward adjustments are made to account for the impact of "ability" and other factors, the contribution of years of schooling to income differentials is still significant. The general level of education and the median family income in the five counties are considerably lower than those of the state of Ohio and of the United States (Acquah, p.8).

The quality of inputs in a production activity has been recognized as a very important determinant of the productivity of such inputs. Changes in labor quality have been used to account for the changes in labor productivity growth (Griliches). Based on available labor characteristics, a suggested hypothesis is that low labor quality is one of the factors accounting for low income and low productivity in the region. Human capital might therefore be a constraint on the general development potential of the five county area. If quality of labor is a constraint to economic development in the area, then policy makers will have to make decisions as to how human capital formation could be increased so as to relax the constraint it imposes on development potentials. One way of assessing the impact of labor quality in the manufacturing industries and of providing economically meaningful information to the local decision makers is a micro level production analysis.

Labor force behavior, particularly quit decisions by workers and layoff decisions by management, is essential in assessing the viability of any sector of an economy. An analysis of quit and layoff behavior is made to provide further information about the labor quality constraint.

Production Analysis

Cobb-Douglas (C-D), modified Cobb-Douglas (modified C-D), and transcendental logarithmic (translog) production functions were tested as alternatives. Based on a comparison of number of significant variables and goodness of fit, a modified C-D function was selected for analyzing manufacturing production processes in the five county area (Ulveling and Fletcher). The statistical form of the production function in log-log form is

$$(1)\quad \ln O = \ln b_o + b_1 \ln F + b_2\left(\frac{M}{F}\ln F\right) + b_3 \ln I + b_4\left(\frac{M}{I}\ln I\right) + b_5 \ln W + b_6\left(\frac{M}{W}\ln W\right) + b_7 \ln M + e,$$

where O is the value of gross output ($); F is the value ($) of the flow services from fixed and variable capital; I is the value ($) of intermediate inputs used during the year; M is the average number of managers during the year; W is the average number of skilled production workers, unskilled and semi-skilled production workers, office workers, and professional and sub-professional workers during the year; and e is the error term.

Since the parameters of the modified C-D are not invariant to scaling, each variable is measured as the ratio of observed value to sample arithmetic mean to facilitate interpretation of the coefficients at the sample means (Griliches and Ringstad, p.10). It is hypothesized that management intensity influences the production elasticities of the other inputs, which is tested by the significance of b_2, b_4, and b_6.

Human Capital and Labor Turnover

Human capital can be in either general form, specific form, or both forms at a point in time (Becker, Parsons). If an individual accumulates skills or knowledge which is peculiar to a specific firm and hence finds it economically difficult to move into an alternative job, then such an individual is thought of as having firm specific human capital. The greater the cost of adjusting (information, transfer, and retraining costs) to an alternative job, the greater the specificity of the human capital formed. There are two major features which affect the relationship between specific human capital and labor turnover: the volume, and its division into worker and firm financed human capital. The distinction between firm financed and worker-financed specific human capital, and the breakdown of labor turnover into quit and layoff components, enables a determination of how the turnover components are influenced by the type of specific human capital.

If it is assumed that an entity (worker or firm) wants to maximize the returns on its investment in human capital, then it is expected that quit behavior (an act which is initiated by an individual worker) is influenced by worker-financed specific human capital (S_w); while layoff behavior (an act which is initiated by a firm) is influenced by firm-financed specific human capital (S_f). Because S_f and S_w cannot be estimated directly, Parsons' indirect approach through the use of total marketable human capital (T) and specific human capital (S) are utilized to obtain the following relationships in simple form:

$$(2) \quad q = c_o + c_1 BRTEN + c_2 EDUC + c_3 WAGE + c_4 OLD + c_5 YOUNG + c_6 FEM + c_7 UNION + u_i,$$

(3) $ly = d_o + d_1 BRTEN + d_2 EDUC + d_3 WAGE + d_4 OLD + d_5 YOUNG + d_6 FEM + d_7 UNION + v_i$,

where q is the quit rate per production worker for a firm; ly is the layoff rate per production worker for a firm; EDUC is the mean years of school completed; BRTEN is the percent of production workers with the firm for less than six months; UNION is the percent of production workers unionized; FEM is the percent of female workers; YOUNG is the percent of production workers under 24 years of age; OLD is the percent of production workers over 55 years of age; and WAGE is the average wage rate of production workers. In equation (2) it is expected that $c_3 < 0$, but the signs of the remaining coefficients are indeterminant. In equation (3), it is expected that d_1, d_3, d_5, and $d_6 > 0$; d_2 and $d_7 < 0$, while d_4 is indeterminant.

Results

The Production Model

The modified C-D production function estimated by ordinary least squares is:

$$\ln O = \underset{}{0.17} + \underset{(0.11)}{0.25}\ln F + \underset{(0.02)}{0.01}\left(\frac{M}{F}\ln F\right) + \underset{(0.05)}{0.56}\ln I - \underset{(0.001)}{0.004}\left(\frac{M}{I}\ln I\right)$$

$$+ \underset{(0.08)}{0.27}\ln W - \underset{(0.01)}{0.02}\left(\frac{M}{W}\ln W\right) + \underset{(0.09)}{0.06}\ln M,\ R^2 = 0.97,\ F = 129,$$

where standard errors are parentheses and there are 35 observations. The estimated elasticities of production (E_i) for the inputs at the arithmetic mean are[2]: $E_F = 0.26$, $E_I = 0.556$, $E_W = 0.25$ and $E_M = 0.06$. Returns to scale at the arithmetic mean are 1.126, which is not significantly different from one. Scale returns decline as M increases. This implies that as M increases, economies of scale are exhausted.

It is hypothesized that management contributes only allocative effect and no worker effect in the manufacturing sector. The results support the view that managers have significant impact on the allocation of other inputs. A two-tailed t-test shows that the estimated coefficient of $\frac{M}{W}\ln I$ is significant at the 0.01 level, while the estimated coefficient for $\frac{M}{W}\ln W$ is significant at the 0.1 level. The coefficient of lnM is not significantly different from zero, supporting the hypothesis of no worker effect. The empirical results support the hypothesis that managers contribute only allocative effect.

Following Berndt and Christensen, the results suggest that the F variable is separable from all other inputs; I and W are separable from each other and F, but they are not separable from M. Attempts to disaggregate production workers into skilled and semi- and unskilled production workers revealed that for the set of data used, no distinction could be made between the two classes of workers. The two classes of labor are nonseparable in the firms surveyed (Acquah).

The Quit Rate Model

Equation (2) was estimated using the data for 32 manufacturing firms which employed eight or more production workers.[3] The result is

$$q = \underset{}{-15} + \underset{(0.13)\ [0.97]}{1.18BRTEN} + \underset{(1.04)\ [0.21]}{3.22EDUC} - \underset{(2.12)\ [-0.23]}{5.89WAGE} + \underset{(0.09)\ [0.10]}{0.16OLD}$$

$$- \underset{(0.14)\ [0.10]}{0.13YOUNG} - \underset{(0.05)\ [-0.07]}{0.05FEM} + \underset{(0.02)\ [0.18]}{0.06UNION}, \quad R^2 = 0.91, \quad F = 33,$$

where standard errors are in parentheses and Beta coefficients in brackets.

The mean of q is 12.63 percent. The young and female variables for which the expected signs were ambiguous had small and insignificant coefficients. The regression coefficient of the wage variable is negative as expected; a unit ($/hour) increase in the wage rate depresses the quit rate by about 5.9 percentage points.

The estimated coefficient for BRTEN is positive. An increase of one percentage point in the proportion of production workers who had been with a firm for less than six months increases quits by 1.18 production workers in every hundred. The length of the reporting period (one year) makes it possible to have more than one quit for each position for the reporting period, and hence makes a coefficient of BRTEN greater than one plausible. The positive coefficient of EDUC implies that education has a greater effect on total than on specific human capital. If wages are held constant, the results imply that an increase in years of formal schooling completed means an increase in general human capital, which in turn leads to higher quit rates.

The coefficient for the proportion of production workers over 55 years of age is positive. This indicates that OLD has a negative relationship with total human capital, and it has greater impact on total human capital than on specific human capital. The estimated coefficient of the union variable (for which the sign was ambiguous) was positive. This suggests that labor unions do perform other duties, like provision of information on alternative or better job opportunities. If wages are held constant, labor unions will assist their members in switching jobs. These results based on micro level data are consistent with those of Parsons which used national aggregate data.

The Layoff Model

Equation (3), without young, was fitted to the same data used for the quit rate analysis. The result is

$$
\begin{aligned}
ly = {} & 37 + 1.02BRTEN - 4.98EDUC + 7.24WAGE - 0.48OLD \\
& \quad (0.23) \quad (2.58) \quad (5.27) \quad (0.24) \\
& \quad [0.70] \quad [-0.27] \quad [0.23] \quad [-0.26] \\
& + 0.06FEM - 0.06UNION, \; R^2 = 0.57, \; F = 5.6, \\
& \quad (0.06) \quad (0.06) \\
& \quad [0.07] \quad [-0.16]
\end{aligned}
$$

where standard errors are in parentheses and Beta coefficients in brackets. The mean of ly is 9.45. As expected, the fit for the layoff equation was not as good as that for the quit rate. This can partly be explained by various dynamic factors that may not be properly controlled for in a cross-section analysis (Parsons, p.1136). Parsons (p.1137) obtained R^2's of .67 and .74 for 1959 and 1963 data, respectively.

The coefficient of the variable OLD, for which the expected sign was ambiguous, was negative. All of the signs of the other estimated coefficients were the same as those expected. The negative sign of the variable OLD implies that it is negatively related to total human capital among workers in the five-county area, i.e., total human capital is greater for younger workers than for older workers.

Although the union and female variables have the expected signs, their estimated coefficients are not significant. The brief-tenure coefficient is significant. If the proportion of production workers with brief-tenure is increased by one unit, there is an associated increase in the layoff rate of 1.02. The length of the reporting period makes it possible to have more than one layoff for each position for the one-year period, and makes a

coefficient of BRTEN greater than one plausible. A one-year increase in mean years of school completed decreases layoffs by almost five in every hundred production workers. These results are consistent with hypothesized behavior and support the results of Parsons for 1959 and 1963.

The empirical results for the quit and layoff rates support the investment hypothesis that the layoff rate is negatively related to a firm's investment in specific human capital, while the quit rate is negatively related to a worker's investment in specific human capital.

Implications for the Region

There was no evidence of a shortage of needed labor skills in the manufacturing sector. There were few skilled (professional) workers, but the demand for these workers was also small. There was no distinction between skilled and unskilled production workers. There was not much difference between the mean hourly wage rates of the skilled ($3.74) and unskilled ($2.69) production workers to suggest such a classification of the labor force; the weighted average wage rate per hour per production worker was $3.29 (with about 42 percent of the production workers classified as skilled). Most firms surveyed (about 60 percent) preferred to hire production workers with less than twelfth grade education; only 10 firms had professionals on their labor force. From the above evidence, it was concluded that most of the production workers were unskilled or at best semi-skilled, and that this was the predominant type of workers required by the firms located in the region.

There was no evidence of substantial specific training--the major means of generating specific human capital given the background of new production workers--being provided by the firms. If specific human capital or skills

are needed, then the firms are expected to provide them. The positive significant coefficient of the education variable in the quit equation suggests that, relatively, not much specific training goes on in the region. The positive sign of the proportion of workers over 55 years of age is further support for the argument that a small amount of specific training is provided to production workers. Human capital theory suggests that older workers are expected to be less mobile because they have accumulated more specific human capital. The positive coefficient of old workers in the quit equation suggests that if wages are held constant, older workers have higher quit rates than younger workers. This implies that little specific human capital has been accumulated over time by the older workers.

Labor turnover is not a problem in the region. It appeared instead to serve as a meaningful adjustment mechanism. The production workers generally had low skills. Neither the worker nor the firm has made substantial investments in specific human capital. A production worker had not accumulated skills or knowledge which is peculiar to a specific firm and finds it economically feasible to move into alternative jobs. Quit rates are expected to be high since there are not large costs of adjusting to alternative jobs. Since the firms have not undertaken any major firm-financed specific human capital investment, there have little incentive to retain their workers when there is a fall in demand for output. It is expected that layoff rates will be high in times of slack demand. In response to increased demand for output, a firm can readily replace or augment its work force with relatively small losses in specific human capital investments of its work force.

Another implication concerns production of intermediate inputs in the region. If a competitive market is assumed, then the share of intermediate

inputs in the total output is about 50 percent. The region supplied only about 26 percent of the intermediate inputs. This means that most of the returns to intermediate inputs (about 41 percent of total output) goes out of the region. To increase economic activities in the region, it might be useful to explore linkages with other industries to provide a greater share of the intermediate inputs locally.

The manufacturing sector is one of the major sources of employment and income in the region. The sector has potential for playing a major role in developing an economic base capable of sustaining economic growth in the region. There are three ways of enhancing the role of the manufacturing sector. The first is to attract further industries requiring low labor skills. Since the region has primarily low-skilled labor, manufacturing activities which require this type of labor will be easiest to attract. The second approach is to encourage increasing educational levels and per capita income through the development of manufacturing components which require skilled labor. The results of this study indicate that there is currently little manufacturing activity requiring skilled workers. If new firms requiring skilled labor could be attracted into the region or existing firms could be induced to add such activities, this would have the effect of encouraging increasing educational levels and higher per capita incomes. A third approach is to encourage new or existing firms to produce more of the intermediate inputs used in the region.

These approaches are not mutually exclusive, and all can be pursued simultaneously. However, to reduce the continuous demand for low skill labor in rural areas, and to provide the basis for human capital and income growth,

focus must shift from attracting branch manufacturing plants requiring low skills and having few linkages with other regional activities to activities which will require and generate higher labor skills and increase inter-industry linkages overtime.

FOOTNOTES

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[1]Specific human capital is defined as the difference between the discounted sum of worker's marginal product in his present firm and his greatest discounted marginal product net of transfer cost in alternative firms (Parsons, 1972).

[2]As a second order Taylor expansion, the function was expanded around arithmetic mean, and the use of arithmetic mean instead of geometric mean is more meaningful.

[3]Through experimentation with various classifications of the firms based on employment, it was found that the group with eight or more employees exhibited stable and consistent results, while the group with seven or less employees yielded unstable, and inconsistent results. In the small firms (less than eight employees) a small change in the number of quits or layoffs leads to a large change in quit and layoff rates.

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